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Series:	Bromley, D. Allan, Files
Subseries:	Global Climate Change Files
OA/ID Number:	62052
Folder ID Number:	62052-006

Folder Title:
Cline Report on Climate Change [1992]

Stack:	Row:	Section:	Shelf:	Position:
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To Jonathan fyi &
then file

DH
6/8

THE WHITE HOUSE
WASHINGTON
June 2, 1992

Excellent memo, Allan. Thanks

MEMORANDUM FOR CLAYTON YEUTTER

FROM: D. ALLAN BROMLEY

SUBJECT: Cline report on Potential Damages from Climate Change

While I was on travel I received your note asking for comment on a summary of a report by William Cline of the Institute for International Economics (IIE) on the potential damages of climate change, and a letter to you from C. Fred Bergsten, Director of IIE, suggesting a briefing on the report.

This note is to provide you with some very preliminary comments; we have not yet seen the published report (I understand it is still in publication). We have seen an outline of the report, and a member of my staff attended Cline's seminar presentation at Resources for the Future (RFF) last month.

Cline's analysis

The best point in Cline's argument is that the calculation of the potential total damages associated with potential global warming cannot stop arbitrarily at an assumed doubling (from pre-industrial levels) of carbon dioxide (CO_2) concentrations in the atmosphere. This is because, as Cline rightly points out, any damages would be associated with the total warming, which could theoretically proceed beyond the level of the climate sensitivity to a CO_2 doubling (i.e., 1.5-4.5 degrees centigrade) if concentrations rise beyond a doubling. It is plausible, if current emissions trends continue, that global concentrations will rise above a doubling of preindustrial CO_2 by sometime around the year 2100.

On this basis, Cline criticizes the damage calculations performed by Nordhaus and others for stopping at a doubling of CO_2 levels. Nordhaus estimated damages to the U.S. economy of 0.26% of GNP lost by 2050 as a result of the 1.5-4.5 degree C warming assumed to occur as a result of doubling CO_2. Cline takes the analysis further, projecting a tripling or higher levels of CO_2, and an associated warming of 10-18 degrees C, by "late in the 23rd century." He then estimates damages of 6% of GNP by that time, up to 20% of GNP under a more "pessimistic" scenario.

Questions about Cline's predictions

Cline's analysis is interesting from a conceptual point of view. But his specific damages estimates are subject to criticism or question on several fronts. First, several of the specific sub-categories are based on unusual assumptions. For example, Cline noted at

the RFF seminar that his estimate of "species loss" was derived by taking the economic losses due to timber losses and salmon run depletions in the Pacific Northwest and "multiplying them by 25." No rationale for this surprising method was articulated. (Perhaps it will be explained in the final report.)

As a result of what seem to be strained assumptions like these, Cline's higher damage estimates are not solely the product of his extending the analysis over a longer time period and higher CO2 concentrations and temperature changes than did Nordhaus. Even stopping at the CO2-doubling assumed by Nordhaus, Cline estimates the damages at about 1% of GNP foregone from a 2.5 degree C warming (four times higher than estimated by Nordhaus).

Second, Cline's extrapolation over three centuries, while fascinating, generates quite tenuous numerical estimates. Cline appears to assume little or no progress in knowledge and technology that could assist adaptation over these centuries. Over the course of hundreds of years, know-how and technology would be likely to change significantly in ways that make societies and economies (and probably ecosystems) much more resilient to warming than they would be with current knowledge. Imagine anyone trying to predict in 1700 what the effects of future climate would be on world agriculture through 2000! Even assuming that this mythical forecaster knew with perfect accuracy what the global temperature record would look like over 1700-2000, he could not possibly foresee the dramatic improvements in agricultural output per acre that have occurred in the past three hundred years. Forecasting damages through 2200 today is similarly likely to overestimate future damages. Hence Cline's damage forecasts may not be as "stunning" as Bergsten's letter remarks.

It is worth noting that when Cline estimates the cost of limiting greenhouse gas emissions, he appears to be quite optimistic about the development of new technologies that will lower the costs of doing so. How then can he not be at least equally optimistic about the development of new technologies and knowledge to lower the costs of adapting to a new climate? One answer might be that rapid short-run warming would be too fast to adapt to, but Cline's projection is far longer-term than that.

Third, because the damages are expected to occur over several centuries, far-off losses would need to be discounted to calculate their present value. But Cline chooses a very low, almost negligible discount rate.

<u>Comparing predicted damages with the costs of preventing warming; no recommendation for stiff targets</u>

Finally, even assuming such high damages and low discount rates, Cline concludes that the cost of limiting emissions to prevent these damages (i.e, to prevent the increase in CO2 concentrations that would generate the higher longer-term temperature changes on which his damages estimates rely) would be about equal to the damages prevented. Thus, even on Cline's analysis, limiting GHG emissions today is only barely cost-beneficial. This is a sobering finding.

Cline therefore ends up advocating not a top-down international target and timetable approach, but rather what he calls an "ambulatory targets approach" that begins with research, reducing energy subsidies, and voluntary national action plans. Only if the research reveals greater urgency would Cline advocate stiffer measures.

This is precisely consistent with U.S. policy and with the Framework Convention on Climate Change we have just negotiated. The point about reducing energy subsidies is one recently made by the World Bank, which estimates in its 1992 World Development Report that eliminating world energy subsidies of $230 billion a year (especially high in Eastern Europe and the CIS) would reduce global CO2 emissions by 10% by 2000, at a net economic gain for those countries. This may be a point the U.S. government could make more forcefully in the future.

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Document Originally
Attached to
Following Page

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6-1-92
Nancy -
Damert asked for + PUS - could you check + give to her

June 2, 1992

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These comments are, again, preliminary, as the final report has not yet been published.

DAB

Jonathan Weiner has prepared some comments on the attached. Nancy agrees.

Do we need to send a note to Cy Vance?

Shall I ask Jonathan to prepare a draft for your signature?

5/2-7

Sara says: Nancy knows about this. She has it.

THE WHITE HOUSE
WASHINGTON

DATE: May 11, 1992

TO: Dr. Bromley

FROM: CLAYTON YEUTTER
Counsellor to the President for
Domestic Policy

Allen, any comment??

Nancy M.
Jonathan W
Comments
please ASAP
DMB
5/18/92

INSTITUTE FOR INTERNATIONAL ECONOMICS

April 30, 1992

Sixth Floor

'ROPOSED TO AVOID
AMAGE
/ING

Economics study by William R. Cline
e earth by the accumulation of carbon
of 10° Celsius (18° Fahrenheit) over the
; economy would total 6 percent of GDP,
high-damage senario, losses could reach
rd estimates, which focus on warming for
he process will continue at least over two
with an economic effect on the order of

narizes Cline's forthcoming book-length
: *Economics of Global Warming* (the table
and climate experts have praised Cline's
r Atmospheric Research, noting that Cline
"is a rare economist, willing to spend years [illegible] out the scientific problem he is working on,"
calls his study "the best balanced and fairest economist's treatment...and a single source for many
of the climatological, agricultural, and ecological aspects of the issue." John Deutch of the
Massachusetts Institute of Technology concludes that "only Cline faces squarely the issue of what
should be done today to reduce the likelihood that in the long run one suffers a catastrophe."

[4] From: Wiener Jonathan B. 4/28/92 11:18AM (3035 bytes: 47 ln)
To: Nida Marian
Receipt Requested
cc: Maynard Nancy G., Hawkins Damar, Wiener Jonathan B.
Subject: Potential meeting with C. Fred Bergsten
---------- Message Contents ----------

Marian:

In Nancy Maynard's absence this week, I found in our in-box a note from Dr. Bromley asking whether he should meet with C. Fred Bergsten, Director of the Institute for International Economics (IIE) here in D.C. Dr. Bergsten had written to Counsellor Clayton Yeutter asking to brief Yeutter on a new paper by William Cline of IIE, regarding the impacts of global warming on the US and world economies. Yeutter had referred the request to Dr. Bromley.

If you need to decide this week, based simply on the issues discussed (I do not know what other contacts Dr. Bromley may have with Bergsten or Cline), I would think it acceptable to meet with Bergsten and/or Cline, perhaps interesting. But I would recommend that, if you can wait until next week, you get Nancy Maynard's reaction on her return from the UK.

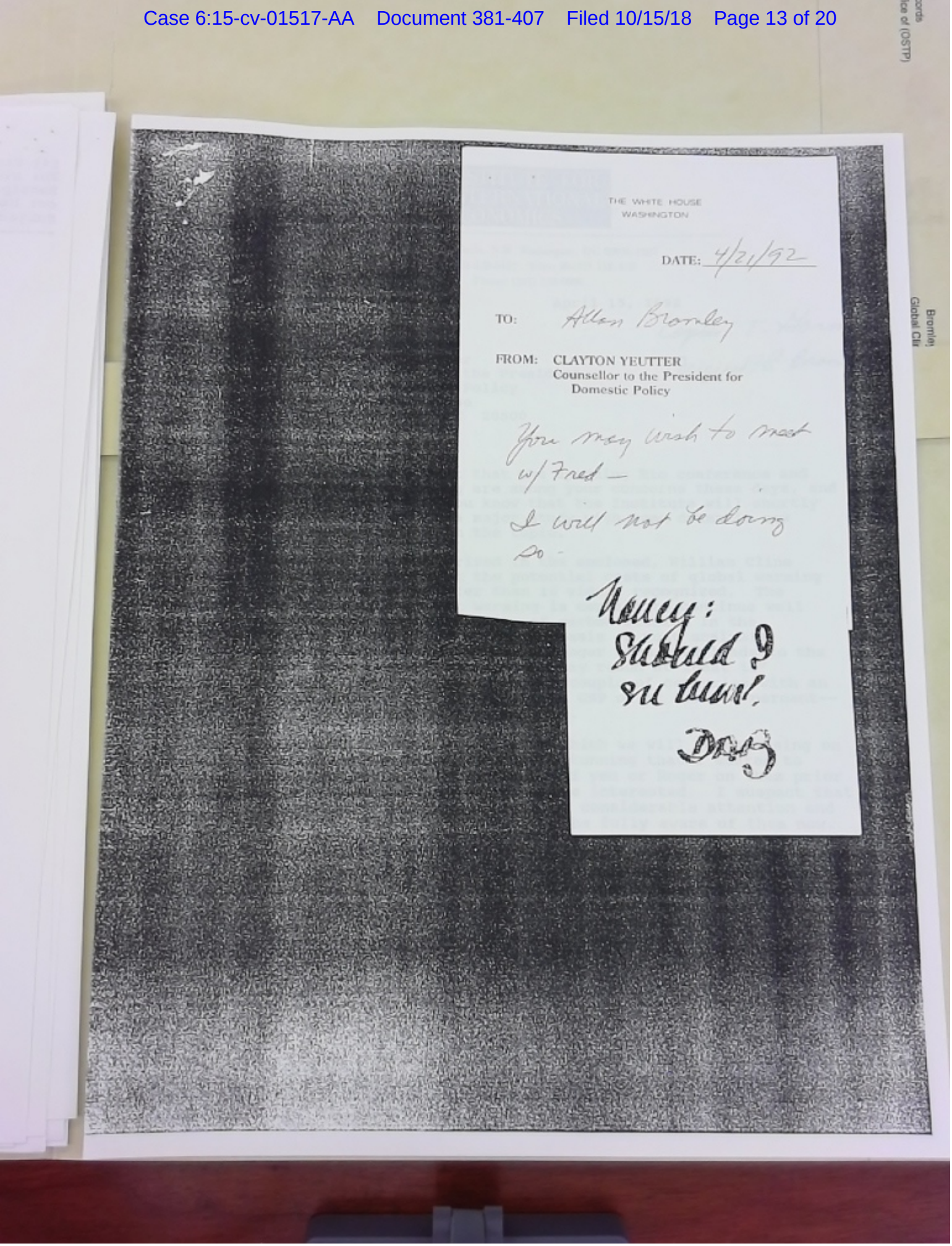
The crux of Cline's argument is that the cost of enduring global warming will be high: 1% of GDP foregone to undergo a 2.5 degree C warming (four times higher than estimated by Nordhaus), and 6% of GDP foregone for a 10 degree C warming.

These estimates depend on GHG emissions and warming continuing steadily for several centuries.

The 6% figure (and an estimate of "long-term damages under the more pessimistic assumptions at approximately 20% of world GDP") are also expected to occur over several centuries. Thus far-off losses would need to be discounted to calculate their present value; Cline chooses a very low, almost negligible discount rate. Furthermore, he appears to assume little or no progress in knowledge and technology that could assist adaptation over these centuries; over the course of hundreds of years, know-how and technology would be likely to change significantly in ways that make societies and economies (and probably ecosystems) much more resilient to warming than they would be with current knowledge. Hence Cline's damage forecasts may not be as "stunning" as Bergsten's letter remarks.

Finally, even assuming such high damages and low discount rates, Cline concludes that limiting GHG emissions today is barely cost-beneficial if at all and may well not be cost-beneficial. This is a sobering finding.

Wait till Nancy gets back



THE WHITE HOUSE
WASHINGTON

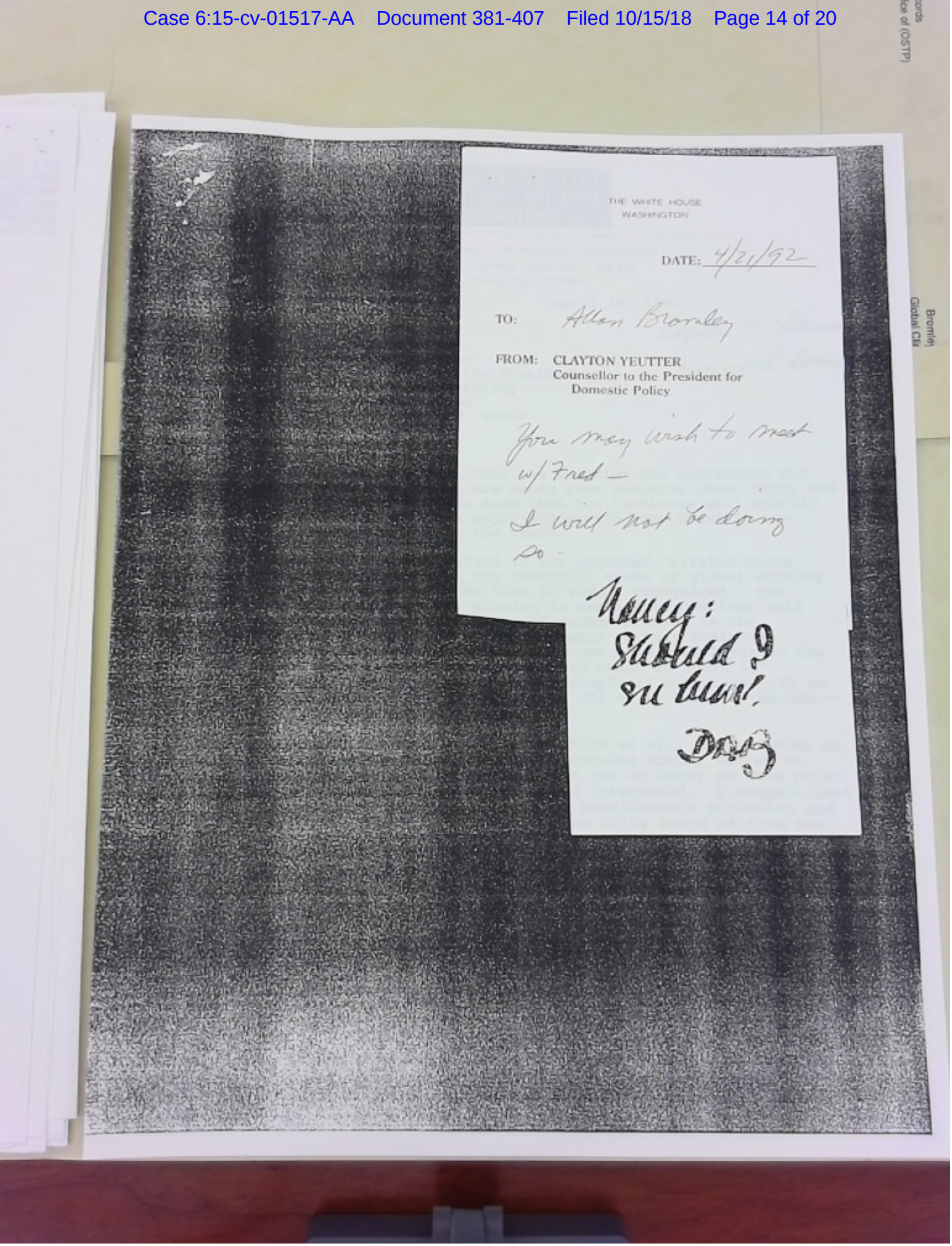
DATE: 4/21/92

TO: Allan Bromley

FROM: CLAYTON YEUTTER
Counsellor to the President for
Domestic Policy

You may wish to meet
w/ Fred —
I will not be doing
so.

Nancy:
Should I
see them?
DHS



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Dan

INSTITUTE FOR INTERNATIONAL ECONOMICS

11 Dupont Circle, N.W. Washington, DC 20036-1207
Fax: (202) 328-5432 Telex: 261271 IIE UR
Phone: (202) 328-9000

April 15, 1992

Copies: T. Thornton
Original to L. Bromley

The Honorable
Clayton Yeutter
Counsellor to the President
for Domestic Policy
The White House
Washington, DC 20500

Dear Clayton:

I suspect that the upcoming Rio conference and global warming are among your concerns these days, and want to let you know that the Institute will shortly be releasing a major study with some dramatic new conclusions on the topic.

As summarized in the enclosed, William Cline concludes that the potential costs of global warming are much greater than is widely recognized. The reason is that warming is certain to continue well beyond the "doubling of carbon dioxide in the atmosphere" that is the basis of most analysis. Adoption of a properly longer term view leads to the conclusion that warming may reach at least 10° centigrade over the next couple of centuries with an attendant hit on American GNP of at least 6 percent--and potentially much more.

These conclusions, which we will be releasing on May 6, are sufficiently stunning that I wanted to offer to drop by and brief you or Roger on them prior to release if you would be interested. I suspect that our findings will receive considerable attention and am thus anxious that you be fully aware of them now.

It was a great pleasure to see you when delivering the Report of our Competitiveness Policy Council--which, incidentally, continues to receive very good reviews--and I would hope to have a chance to do so on global warming. I know it is not one of your easier problems!

Sincerely,

Fred

C. Fred Bergsten
Director

cc: Roger Porter

THE ECONOMICS OF GLOBAL WARMING

William R. Cline
Senior Fellow
Institute for International Economics
Pre-publication Draft
March 30, 1992

Summary

As represented by the Intergovernmental Panel on Climate Change, the majority scientific view is that the "greenhouse effect" will cause significant global warming by the middle of the next century in the absence of policy intervention (chapter 1). Most European countries, Japan, Canada, Australia and New Zealand have set targets for reducing emissions of carbon dioxide, the principal greenhouse gas. US policymakers have refused to do so, on grounds of scientific uncertainty (chapter 8).

Most economic analyses of the problem have focused on estimating the cost of abatement with the use of energy-economic models (e.g. Manne and Richels, 1990; Jorgenson and Wilcoxen, 1990). Nordhaus (1991) has gone further and examined the optimal degree of abatement by considering benefits of damage avoidance as well. He finds that only modest action is warranted. The present study suggests instead that social benefit/cost ratios are favorable for an aggressive program of international abatement. The difference stems in part from a longer-term perspective that takes account of much greater warming and damage (chapter 7, annex 7A).

Scientific Framework and Very-long-term Warming

Carbon dioxide and other trace gases (methane, chlorofluorocarbides, nitrous oxide, ozone) are transparent to incoming short-wave solar radiation but opaque to outgoing long-wave (infrared) radiation from the earth. Their natural levels raise the earth's average temperature from -18°C to +15°C. Climatologists have applied large general circulation models (GCMs) to estimate that a doubling of carbon-dioxide-equivalent above preindustrial concentrations would increase global mean temperatures by a "best guess" estimate of 2.5°C (= Λ, the climate sensitivity parameter), with bounds of 1.5 and 4.5°C (chapter 1).

Most analyses have focused on this rather artificial benchmark. Yet the doubling of carbon-dioxide-equivalent is expected to arrive as soon as the year 2025 under "business as usual," with corresponding warming already "committed" by that date actually arriving by perhaps 2050 after allowance for ocean thermal lag. Because global warming is cumulative and irreversible, a much longer horizon should be considered. The IPCC itself calculates that under business as usual, the commitment to warming would reach 5.7°C by the year 2100 (for Λ=2.5; IPCC, 1990b, p. 191). However, further warming would be likely to continue through at least the year 2300, when deep ocean mixing could begin to reverse partially the increase in atmospheric concentrations (Sundquist, 1990).

In view of economic growth and fossil fuel reserves, global emissions could increase from 6 billion tons of carbon (GtC) today to 20 by the year 2100 and over 50 GtC by late in the 23rd century (chapter 2). By then, atmospheric concentrations of carbon could multiply eight-fold. Global temperatures would rise by a central estimate of 10°C for Λ=2.5 and by 18°C for the upper-bound Λ=4.5 (based on the standard logarithmic formula for radiative forcing of carbon dioxide and incorporating the influence of other trace gases; chapter 2). Thus, *global warming in the very-long-term is far higher than the 2° to 3°C range usually considered* -- simply because the process does not stop at the conventional $2xCO_2$ benchmark.

Economic Damage

Chapter 3 attempts to estimate the size of economic damage from global warming at both the conventional benchmark ($2xCO_2$) and very-long-term warming levels. Scaled to the current size of the US economy, agricultural losses from heat stress and drought associated with benchmark (2.5°C) warming would amount to some $18 billion annually. "Carbon fertilization" effects of higher carbon dioxide are sometimes believed to neutralize damages, but such calculations tend to forget that increases in other trace gases mean atmospheric carbon dioxide is considerably less than double when carbon-equivalent doubles. Similarly, farm adaptation is often cited as an offset, but at least one careful study suggests that about two-thirds of these losses would occur even with favorable adaptation assumptions.

Annual losses from sea-level rise would amount to an estimated $7 billion. Increased electricity requirements for air conditioning would amount to some $12 billion annually, with an offset of only about one-tenth for reduced heating costs (largely because of the much greater inefficiency of electric power in view of transmission losses). Lesser runoff in water basins would cause costs of some $7 billion annually from curtailed water supply. Increased urban pollution (tropospheric ozone) associated with warmer weather would impose an annual cost on the order of $4 billion. Increased incidence of mortality with heat stress would amount to some $6 billion in annual losses with life conservatively valued at lifetime earnings (risk pooling would suggest higher valuation). The lumber value of forest loss would be over $3 billion annually. Ski industry losses would be some $1-1/2 billion annually. Other tangible costs would arise from increased hurricane and forest fire damage, and net infrastructure costs from increased immigration. As this enumeration indicates, it is misleading to argue that damages would be small in economies where the share of agriculture and other "outdoor" sectors is small. Several major effects are not limited to such sectors, and even agricultural effects must take account of loss of consumer surplus and so can be understated by consideration of ex-ante sectoral share.

Overall, damages for 2.5°C warming at present US economic scale would be close to $60 billion, or 1 percent of GNP ("d_0"). Intangible losses, particularly species loss but also human disamenity, could raise the total considerably higher. Somewhat surprisingly, 1 percent of GNP loss is the same central value as used by Nordhaus (1991), although his direct estimate is only 1/4 percent of GNP. For other countries, especially island nations, losses could be much higher.[1]

The damages would be much higher with very-long-term warming. Even a linear damage function would mean losses four times as high (for 10°C warming instead of 2-1/2°C). However, damage is likely to be non-linear. Consider sea-level rise. In the initial range, the Antarctic does not contribute to sea-level rise because temperature is in a low range where increased melting is more than offset by increased snow carried by air with more moisture. On the scale of 10°C warming, the Antarctic would become a major source of sea-level rise, especially if the West Antarctic ice shelf disintegrated. Similarly, for agriculture heat stress could be expected to impose non-linear damage. The central estimate in chapter 3 is that the damage function is geometric with an exponent (γ) of 1.3, so that overall damages reach 6 percent of GNP with 10°C warming ("d_1" $= 1\% \times [10/2.5]^{1.3}$). The sensitivity analysis of chapter 7 places the prospective long-term damages under the more pessimistic assumptions at approximately 20 percent of world GNP.

Abatement Costs

Much more work has been done on the side of carbon abatement costs than on damages from global warming. As reviewed in chapter 4, several energy-economic-carbon models provide simulations of the economic cost of constraining carbon emissions. Some have more detail on alternative energy technologies (Manne and Richels, 1990; Edmonds and Barns, 1990); others emphasize economic sectoral detail (Jorgenson-Wilcoxen, 1990); others stress international trading (Burniaux et al. 1991a). Most of the models indicate that a loss of about 2 percent of GDP would result from a reduction of carbon emissions by 50 percent from baseline levels by about the middle of the next century. The cost of the cutback rises with the percent cut from baseline, but falls over time because of the widening range of technological alternatives from technical change.

There is another body of literature that suggests some initial cutback (e.g. "z_0" percent) can be obtained for free. The engineering tradition cites several areas (such as compact fluorescent lights) where energy needs may be reduced at zero or even negative cost. Market imperfections such as utility pricing rules that do not reward energy saved may contribute to this situation. As surveyed in chapter 5, studies by the US National Academy of Science (1991) and others suggest that this initial tranche of zero-cost energy reduction may be on the order of 20 percent.

Abatement costs can be further cut through forestry measures. Whereas the marginal cost (and tax) required to cut one ton of carbon emissions is on the order of $100 to $250 per ton from the simulation models described above, afforestation or reduced deforestation can provide the same cutback at a marginal cost of only about $10 per ton of carbon (chapter 5). However, there are feasible limits for afforestation area. Moreover, afforestation absorbs carbon only during the growing period of some 30 years; a steady-state forest provides no further contribution, because the carbon sequestered in new trees is offset by that released by those that die.

Finally, carbon permit trading across nations can reduce global abatement costs by as much as one-half by shifting the cutbacks to the areas where they have the smallest impact on output (see the discussion of Burniaux et al, 1991a, in chapter 5). A classic example is that carbon reductions for, say, the Netherlands can be most economically accomplished indirectly through assisting, say, Poland to reduce its high emissions levels.

Discounting

Policy analysis over a 300 year horizon depends crucially on the time discount rate (i.e. the real interest rate used to convert future values to comparability with today's values), especially when there is a significant lag between abatement costs and the later benefits of avoided global warming. Present practice varies widely; the US Office of Management and Budget discounts at 10 percent real; the Congressional Budget Office, at the real long-term government bond rate, or 2 percent. For intergenerational issues there is a case for applying a zero discount rate (Mishan, 1975, p. 209); and environmental degradation may "oppress" the future generation even if it is richer (Sen, 1982, pp. 347-9).

The analysis in chapters 6 and 7 conservatively remains with recent mainstream methodology, which converts all effects to consumption equivalents (using a shadow price of capital) and then discounts at the social rate of time preference, SRTP. As developed in chapter 6, the appropriate value for the SRTP is based on the rate of growth of percapita income, because it is the rising level of consumption that makes the "marginal utility" of future income worth less than that today and therefore provides the underlying rationale for discounting future consumption.[2] The resulting rate of social time preference is 1-1/2 percent. When shadow pricing of capital is taken into account, the effective discount rate is on the order of 2 percent.

Benefit-cost Synthesis

Chapter 7 then examines a global policy of cutting carbon emissions back to 4 GtC annually and holding them at that level over 3 centuries. All costs are scaled up by 20 percent to cover parallel action on other greenhouse gases. Benefits are set at 80 percent of greenhouse damages, under the assumption that 20 percent cannot be avoided. Benefits are expanded to include 30 percent of carbon tax revenue, on grounds that this revenue would reduce the economic losses imposed by the disincentive effects of the existing tax structure. For the first 30 years, much of the emissions cutback is accomplished by forestry measures at low cost. However, by the year 2100 carbon cutbacks in the rest of the economy are on the order of 80 percent from baseline. Even so, total abatement costs peak at about 3-1/2 percent of GNP by about 2040, and plateau thereafter at 2-1/2 percent (a floor imposed; otherwise the time variable in the cost function would push costs even lower).

With the central values of key parameters, benefits of damage avoidance do not quite cover costs: the ratio of the present discounted value of benefits to that of costs is approximately 3/4. However, if policymakers are risk averse and apply a weight of one-half to the central outcome, and a weight three times as high to the high-damage outcome as to the low-damage case, the weighted present value of benefits exceeds that of abatement costs (with a benefit/cost ratio of approximately 1.2). Even if a higher discount rate of 5 percent is applied, it requires only

the incorporation of a small probability of a "catastrophe" to boost the benefit/cost ratio into the range favorable for aggressive action.

Policy Implications

In sum, under risk aversion it appears sensible on economic grounds to undertake aggressive abatement to sharply curtail the greenhouse effect. International action will have to face formidable free-rider problems, although the willingness of the European Community and other key nations to take unilateral action is encouraging in this regard. An obvious first step is to remove subsidies to carbon emissions (e.g. German coal subsidies, subsidized electricity in China and other developing countries). An optimal strategy will probably include emphasis on low-cost forestry measures for at least the first decade as scientific consensus is strengthened. It would be advisable to put machinery in place for a carbon tax regime, with mild rates at first but scope for intensification upon scientific confirmation. It will be important for developing countries to participate eventually, because they will provide the lion's share of future increases in global emissions. For this purpose, a moderate portion of carbon tax revenue would appropriately be channeled to developing countries to support technological shift toward a carbon-lean economy and reduced deforestation. Over the longer term, it may be necessary to come to grips with some form of international carbon quotas, along with tradable permits. Allocation of such quotas would presumably have to incorporate elements of realism (e.g. existing GNP and carbon emissions shares) and equity (e.g. base-period population). By early in the 21st century, it could also prove necessary to supplement positive incentives with negative reinforcement in the form of trade sanctions, as provided for in the case of CFCs under the Montreal Protocol. Chapter 8 sets forth a two-phase policy package along these lines.

---

1. Developing countries tend to be located closer to the equator where warming would be lesser. However, their economies tend to be more rigid and more exposed to hurricanes and agricultural damage.

2. More specifically, the SRTP is the rate of growth of percapita income multiplied by the elasticity of marginal utility with respect to income. There is no allowance for pure myopia, an effect that is particularly inappropriate over an inter-generational horizon.